

Attention and selection behavior on ‘universal search’ result pages

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ABSTRACT

The ISO norm line 9241 states some criteria for ergonomics of human system interaction. In markets with a huge variety of offers and little possibility of differentiation, providers can gain a decisive competitive advantage by user oriented interfaces. A precondition for this is that relevant information can be obtained for entrepreneurial decisions in this regard. To test how users of universal search result pages use those pages and pay attention to different elements, an eye tracking experiment with a mixed design has been developed. Twenty subjects were confronted with search engine result pages (SERPs) and were instructed to make a decision while conditions “national vs. international city” and “with vs. without miniaturized Google map” were used. Different parameters like fixation count, duration and time to first fixation were computed from the eye tracking raw data and supplemented by click rate data as well as data from questionnaires. Results of this pilot study revealed some remarkable facts like a vampire effect on miniaturized Google maps. Furthermore, Google maps did not shorten the process of decision making, Google ads were not fixated, visual attention on SERPs was influenced by position of the elements on the SERP and by the users’ familiarity with the search target. These results support the theory of Amount of Invested Mental Effort (AIME) and give providers empirical evidence to take users’ expectations into account. Furthermore, the results indicated that the task oriented goal mode of participants was a moderator for the attention spent on ads. Most important, SERPs with images attracted the viewers’ attention much longer than those without images. This unique selling proposition may lead to a distortion of competition on markets.

1. INTRODUCTION

Besides conventional media the internet gains a high significance in fields as education, entertainment and consumption in various social fields despite a global economic crisis. According to ZenithOptimedia, “internet advertising will grow by US\$31.3 billion, from US\$63.7 to US\$95.0 billion between 2010 and 2013” (2011, p.4). The expenses on online promotion exceed those of print media.

Opposed there is a journalist’s résumé during a symposium of the IT Society ITG stating that “Mensch und Maschine können oft nicht miteinander [man and machine often mismatch]” (FAZ, 1998, p. T-2). Using a striking slogan, the journalist alludes to the phenomenon of the interaction of man and technology. Developers are able to deliver equipment fully matured with optionally designed surfaces up to Embodied Conversational Agents and Avatars (Bailenson et al., 2005; Bickmore et al., 2009; Nass, 2004). But users do not seem to be able to utilize these interface designs efficiently and “accident free” despite numerous innovations according to designers’ intentions (Norman, 1981; Rasmussen, 1982; Thatcher et al., 2006; Hawthorn, 2003). Relationship between man and machine could be that easy: The constructor creates an interface and users ask the constructor how it should be operated. Such behavior is hardly to be observed in everyday life. Just think of the lax handling of users’ manuals which remain unread and users do not get the constructor’s information. The physicist Herrmann von Helmholtz (1867) characterized the expression of ‘unconscious inference’ to point out that sensation is spontaneous without cognitive effort and that they have an exceeding effect on the viewer “...als gewonnen durch eine uns zwingende, gleichsam äussere Macht, über die unser Wille keine Gewalt hat. [obtained by a compelling external force about which our will has no power]” (Helmholtz, 1867, S. 449). These non-actionable interpretation practices entail that the resulting interaction may be much more influenced on affect loaded information than by objective information (Möller, 2007). Even in jurisdiction, where only impartial facts should be considered, it could be proved by Downs and Lyons (1991) that attractiveness affected the jury’s judgment slightly. A kind of manipulation on an effective-emotional, cognitive level or behavioral level may be caused by apparently incidental appearance, which is effective on the interpersonal level (Watzlawick et al., 1968). For this reason, considerable annual expenses for cosmetics or plastic surgery seem to be worthwhile according to the so-called impression management phenomenon by Goffman (1959). This phenomenon may be regarded as a

kind of personal promotion we do use more or less intuitively. Next to this, a market exists on which promotion is realized as commercials and other kinds of persuasion of people.

The promotional communication represents an excellent field of application for this kind of persuasion. Subliminal perception of advertising seems to affect our cognition, emotions and behavior unopposed (Loftus and Klinger, 1992) and this is why they are illegal in most countries. But even if we can be aware of ads, we don't remember them in everyday life. This is why for example internet ads offer further marketing strategies concerning advertising impacts in research (e.g., Ferreira, et al., 2011). This can be constituted by the suggestive puissance of the applied advertising media (Frey, 2003) as well as the internal attitude to information processing. The latter resorts to the two-process-constructs established in psychology as high and low involvement of social judgment theory (Sherif and Cantril, 1947) and the here from generated Elaboration Likelihood Model by Petty and Cacioppo (1979) and Heuristic Systematic Model (Chaiken, 1980). Pictures used as design elements in advertising have an increasing meaning owing to an information overload in western media societies and therefore they do have a main communication function in print media within the last decades (Kroeber-Riel, 1999). The inherent possibility of a fast, descriptive and emotional communication (Frey, 1998; Schierl, 2001) of analogue picture codes (Watzlawick et al. 1968) can also be considered as an additional benefit in commercial communication. Under tightened competitive conditions pictures achieve a strategic importance for the communication success from the communicator's perspective as well as for the 'return on investment', which is the most important criterion of advertising success (Mattenklott, 2004). It can be deduced that picture-selecting processes have an emphasized role in advertising and promotion in general. If one is able to create designs that attract attention effectually involving affective-emotional or motivational response or intended behavior, providers can gain a decisive competitive advantage by user oriented interfaces especially in markets with a large variety of offers and little possibility of differentiation. A precondition of this is that relevant information can be obtained for entrepreneurial decisions in this regard.

For this reason a pilot study was conducted to measure the distribution of attention and the selection behavior on so called "Universal Search" engine result pages (SERPs). The following research questions were formulated. RQ1: "Do mini maps absorb viewers' attention?" RQ2: "Does efficiency of search tasks varies with visible versus missing of mini maps?" In respect to eye tracking methodology, it is assumed that the user's visual attention is focused on the object that is also the object of the cognitive processing (eye-mind hypothesis, cf. Just and Carpenter, 1980). It is further assumed that the time of fixation corresponds to the time of cognitive processing (immediacy assumption hypothesis, cf. *ibid*).

2. SOME IMPLICATIONS ON DESIGN

Shneiderman and Plaisant (2009), Nielsen (1999), and Nielsen and Pernice (2009) have established a set of rules especially for web designs to achieve user's attention and selection behavior mentioned above. These base upon ergonomics of human system interaction founded in the parts of ISO 9241 dealing with effectiveness, efficiency and acceptance. "ISO 9241-110:2006 focuses on dialogue principles related to the ergonomic design of the dialogue between user and interactive system, and does not consider any other aspect of design such as marketing, aesthetics or corporate design." (International Organization for Standardization, 2011). If and in what extent these standards will be realized should be proved by a variety of evaluation methods (US Department of Health & Human Services, 2011). In compliance with the data source methods can be divided in those based on expert knowledge and those based on user data. The former can distinguish inspection methods (Nielsen and Mack, 1994) from model-based methods (Freedman and Weinberg, 1990). The latter cover monitoring and survey settings of users up to user tests. In 1980s Donald Norman established the concept of 'User Experience' (1981). He pointed to a paradox of human-system interaction. If usability has mainly treated human-system interaction for creating mandatory standards, the remunerative video game market caused a revise in opinion (Vorderer and Bryant, 2006). Emotions have a strong relevance for the cognition and evaluation of designs, therefore Donald Norman spoke about 'Emotional Design' (Norman, 2004). Those pragmatic inferences by users lead to an expansion in the theoretical understanding from usability to enjoyment (Blythe et al., 2003). Marc Hassenzahl (2003) developed a model of user experience which attaches importance to the designer perspective as well as to user perspective. According to Hassenzahl (2003), the user perspective includes the apparent product character, which are the pragmatic attributes as well as hedonic attributes like stimulation, identification and evocation. That means the judgment about the product is not only based on rational choice, but on product's appeal, its emotional and behavioral consequences during specific usage situations. So the goal of this pilot study was, to get empirical evidence on the pragmatic and hedonic aspects of SERPs and its visual cognition. For this, the above-mentioned research questions were specified by the following hypothesis. With H1 it was assumed that if a mini map is visible, the viewers' attention will be different in the way that the fixation duration will be higher and that the mini map will show the smallest time to first fixation of all 'areas of

interest' (AOIs). With H2 it was assumed that an implemented mini map reduces efficiency. Efficiency was measured by time until mouse-click interval and it was assumed that participants need more time for their decision if a SERP with a mini map was presented.

3. METHOD

3.1 Design

The experiment followed a randomized 2x2 mixed-design. First factor was the condition of the SERP screenshot (with vs. without mini map). Second factor was the respective city (search target: national city Hannover, Germany or the international city Houston, USA). The first group saw the stimuli "Hannover with mini map" + "Houston without mini map" while the second group's stimuli included "Hannover without mini map" + "Houston with mini map".

3.2 Material

Screenshots of Google SERPs were used as stimuli. In order to have identical Google advertisements and SERPs for all subjects, screen shots were produced for the three search terms 'Stadtplan Hannover' [city map Hannover], 'Hannover Stadtplan Innenstadt' [Hannover inner city map] and 'map Houston'.

3.3 Participants

Because it was just a pilot study, only 20 subjects were recruited. All participants were either students or employees at the German Sport University Cologne. In both groups men and women were equally balanced. Participants' mean age was 35.2 years (SD=13.86 years). Educational achievement was high, because only three persons (15 %) did not hold the general baccalaureate. Experiences in computer usage was balanced over conditions, because half of the sample indicated that they utilized computer programs but did not configure them by themselves and that they would consult other persons when having problems using computers. The other 50 percent was rated as experienced computer users, judged by this criterion.

3.4 Measure

In the study we used an observation and a survey with the help of a questionnaire as methods. Items included participants' preferred web browsers, a specific search engine or a specific mapping. Because cognitive processes like the recall bias (Schwarz, 2007) may have an impact on participants' declarations, eye tracking methodology (Duchowski, 2007) was used additionally. The use of this elaborate method was necessary in order to catch spontaneous user behavior that is less biased by willful processes. Oculometrics (Duchowski, 2007) were recorded during the entire measuring section. For the signal denoising, each participant was calibrated (Tobii, 2010) and blinks were marked as (0,0) in raw data. Those gaps in raw data were not interpolated. Stimuli were always centered in the middle of the screen monitor, to minimize decrease of accuracy in peripheral regions (Duchowski, 2007). Video and audio of all participants were recorded with a webcam in parallel and integrated with the stimuli presented and the tracking data into an overall view. Therefore, the test procedure chosen here follows the precondition of constructive behavioral measuring (Frey et al., 1979). This procedure had the advantage that no reduction of data occurred during the acquisition of the raw data. Furthermore, various parameters could be determined from the raw data. For this purpose so-called areas of interest (AOI) were defined. For each AOI, four parameters were computed from the raw data following the Tobii Studio user manual (Tobii, 2010):

- 1) Fixation count [number of fixations within an AOI; McCarley et al., 2004],
- 2) Absolute duration of the fixations [sum of seconds spent on an AOI; Karatekin, 2007],
- 3) Time to first fixation [the time in seconds from the onset of the stimulus until the first fixation was detected in an AOI; Byrne et al., 1999],
- 4) Time until first mouse click [time subject needed to make a decision; Byrne et al., 1999, Möller et al., 2009],

A fixation occurs when an eye movement rests for at least 200 milliseconds on an area of 50 pixels (Rayner, 1992; Duchowski, 2007).

3.5 Procedure

The subjects were seated on an office chair in front of a 46-inch plasma screen monitor. The distance participant to monitor was approx. two meters (6.6 ft.). The eye-tracking unit stood about 70 centimeters (= 2.297 ft) away from each subject and therefore was outside the regular sight field. All instructions, stimuli

and questions were shown on the screen to avoid distortions caused by the experimenter. In order to get the subjects used to the situation and gain their attention they were informed that they were participating in a perception experiment. First a Stroop test for word recognition was conducted, followed by a geometrical-optical illusion. Then the subjects were asked to look at an advertisement for eight seconds. In the advertisement, an endorser with a visible physical handicap was promoting a fictional automobile brand. Besides the car brand, subjects were questioned about any conspicuous issues concerning the endorser. Then the subjects received written instructions to click on an item they desired in the following screenshot of an online advertisement. The related stimulus page showed a screen shot from eBay with integrated advertising. After subjects indicated their choice by mouse-click they were confronted with a recognition test in which subjects should indicate any sponsor who was visible on the eBay site. Next subjects were shown a picture of a table tennis athlete in a tuxedo and asked to assign a name to him from a list of choices. The participants were shown a picture of the same athlete performing his sport and were asked for a name choice. This was all not relevant for the research questions but was used to cover the real intention of the experiment. The then following instruction was: "Imagine you are in Hannover and are looking for the AWD-Arena to watch a soccer game". A search term had to be selected from a prepared list. The next page showed the information: "In the following you will find a search result page one could for example get by searching for the terms like 'Stadtplan Hannover'. Please choose spontaneously anything guiding to the target. A city map of Hannover will be shown to you for ten seconds during which you are to memorize distinctive points." Then the screen shot of the Universal Search SERP 'Hannover with miniaturized Google map' followed. After a click on a random area of the screen shot an excerpt of the city map of Hannover with the area around the AWD-Arena was presented for ten seconds. Thereafter the subjects were asked to choose from a list the option corresponding to a detail in the map section just shown. Then the following instruction was presented: "Imagine you are on vacation in Houston, Texas and want to attend a basketball game in the Toyota Sports Center." Then the question about the preferred search term followed again and the presentation of the screen shot of an ordinary SERP, without the miniaturized Google map. Here again, an area guiding to the target had to be selected by mouse click.

After the click a map detail appeared again, this time from Houston. On this map section the participants had to memorize details one of which was asked about through a menu of choices. Half of the subjects participated under these conditions. The other, structurally equal half received the complementary content, which is a SERP from Hannover without the miniaturized Google map and that from Houston with miniaturized Google map in the SERP. After the eye tracking test the 20 subjects stated their preferred web browser, search engine and map service indicated in a list of choices. The preferences within this sampling are clearly visible. It is noteworthy that a kind of market dominance by Google could not be shown for web browsers. This can be explained by the fact that the subjects had to actively remember (recognition) during the questioning, and that this memory could be distorted as opposed to the actual usage. On the other hand, this company has a strong position among search engines and especially among map services.

After participants finished the questionnaire, they got a debriefing and were informed about the real aim of the experiment. The participants were thanked and dismissed.

4. RESULTS

4.1 Short report

(1) Miniaturized Google maps show a vampire effect.

It is known from advertising research that advertisements with big name celebrities will attract almost the entire attention of the viewer in such a way that the actual information about the product is hardly noticed and not remembered. Such a skewed distribution of attention always showed up when Google SERPs were shown as 'universal search' result pages including miniaturized Google maps.

(2) Users' decision making processes are not shortened by miniaturized Google maps on SERPs and thus not made easier.

The use of miniaturized Google maps is leading to intended targets and thereby fulfills the criterion of effectiveness. Yet usability is negatively affected because the users spend extremely long time looking at the miniaturized map before making a decision. Therefore this design feature does not fulfill the criterion of efficiency. Users are distracted from the intended goal of gaining information, which potentially reduces the rate of criterion of satisfaction.

(3) The visual attention for individual links on the SERPs is influenced by specific factors.

The distribution of the visual attention for individual links on the SERPs depends on A) their positioning on the SERP and B) the users' familiarity with the target of the search. Links that are positioned very high in the display are selected much more often than those on lower ranks. The scanning behavior is moderated by the cognitive representation of "Hannover" than of the city of "Houston". Accordingly, Hannover was anchored stronger in the memory of the users. The scanning behavior of the subjects varied within the two search terms (both without the miniaturized Google maps, cf. fig.2), and the test subjects showed a wider spaced page scanning behavior looking for the city of "Houston" than for the city of "Hannover".

(4) The "ads" on the SERPs' sites were not clicked on nor viewed.

Based on the search words or terms entered, Google presents to users so-called ads in the right column of the SERPs which can be clicked on. These advertisements were neither noticed visually, nor clicked on.

4.2 Detailed results

As a first analytical step, the left mouse clicks of the subjects were documented in the four target pictures and heat maps of fixation duration were generated. Figure 1 shows the two SERPs with miniaturized Google maps; these elements generated the major portion of the viewers' total visual attention duration to them ($M_{\text{map}} = 2.8$ s, $SD = 2.1$; $M_{\text{links}} = 1.8$ s, $SD = 1.3$), in the sense of a vampire effect (v. Rosenstiel and Neumann, 1988). Due to the data a t-test for paired samples of maps vs. links was computed for time to first fixation (TFF).

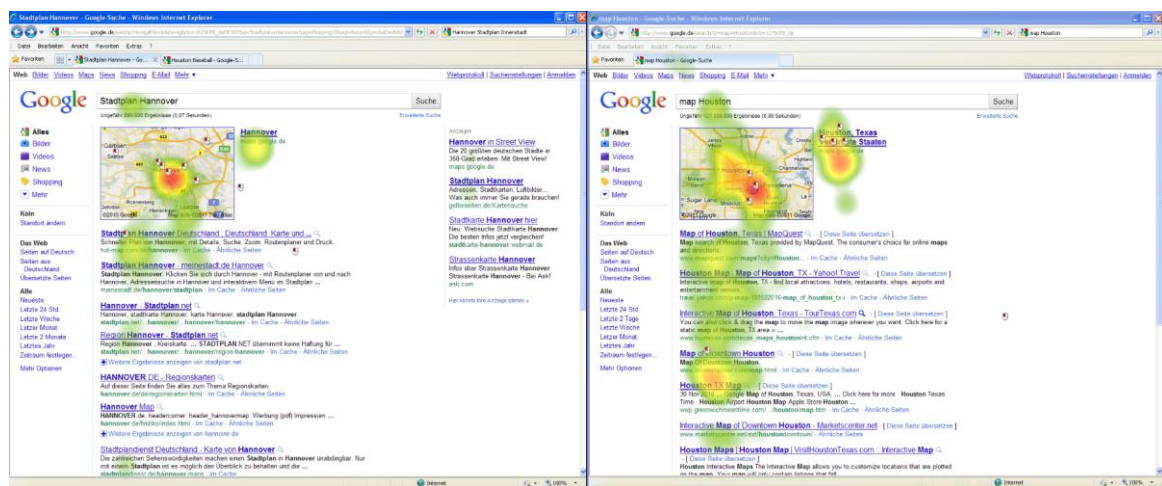


Figure 1. Mouse clicks and fixation duration of the national (left) and international (right) SERP.

Maps evoked a shorter TFF ($M=1.3$, $SD=1.1$) as the SERPs without miniaturized map did ($M=3.8$, $SD=2.1$). $T_{(17)}=4.84$ was significant ($p<0.001$) with $d_z=1.14$ and $H1$ must be regarded as verified. A remarkable difference exists between the national (left) and the international (right) target, relating to the number of mouse clicks, as shown in the following graphic representation of the click distribution in percentages of the users. For the search word "Hannover" the Universal Search SERP's miniaturized Google Map received eight clicks (80%), twice the number of clicks for the Google map on the SERP for the search word "Houston" (three clicks 33.3%). $X^2=5.051$, $p=.025$, $\Phi=.503$. On the last mentioned SERP the Google-Link was chosen the most, with four mouse clicks. This suggests that the selection behavior is actually influenced by the kind of the cognitive representation of the target and should be taken into account in further studies.

This assumption is supported by the two SERPs that have no miniaturized Google Map (fig. 2). The SERP for "Hannover Stadtplan Innenstadt" [Hannover inner city map] shows a total viewing time of 21.1 seconds and with a click amount of 90% of the subjects a distinct focusing on the first link. For the "map Houston" without Google miniaturized map the total viewing time on the first link is also highest with 25.6 s, yet two subjects chose the seventh link. The differences in viewing time were statistically not relevant ($t_{(18)}=-.91$, $p>.375$). An explanation for this behavior cannot be delivered in the context of a pilot study, but should be further pursued in regard of the impact of cognitive representation.

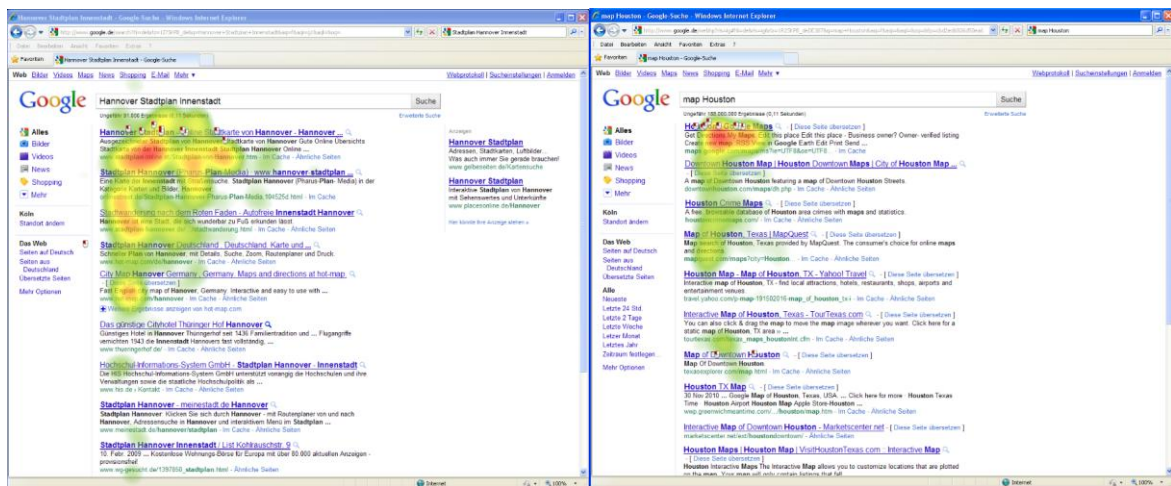
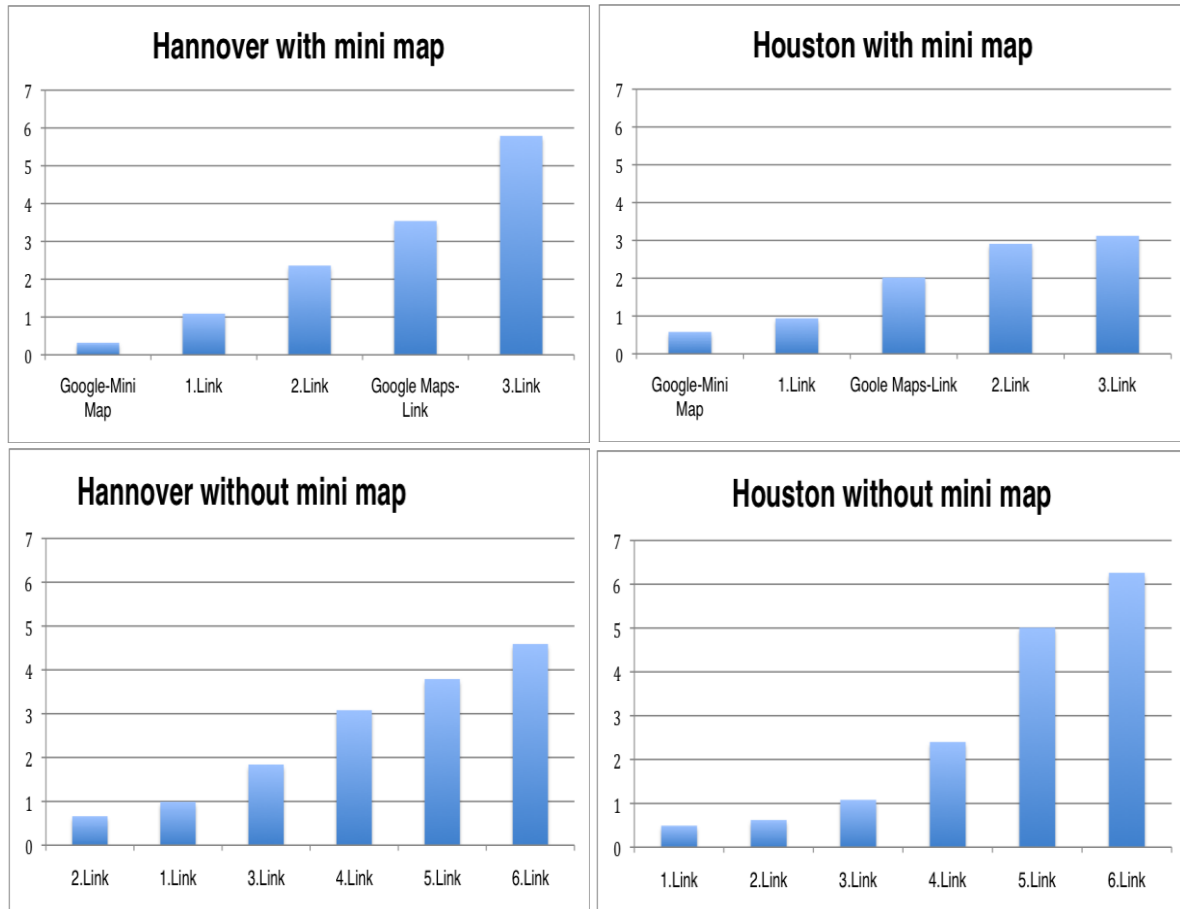


Figure 2. Mouse clicks and fixation duration on SERPs without miniaturized Google map for both target cities.

It is remarkable that the miniaturized Google maps do not contribute to quicker decision-making and clicking behavior but rather make the decision finding less efficient ($M_{\text{with map}}=15.07$ s, $SD=8.56$, $M_{\text{without map}}=7.26$ s, $SD=5.02$). T-test for paired samples is significant ($t_{(19)}=3.82$, $p<.001$, $d_z=.854$), so that H2 is verified. On average, ten subjects needed 16.03 seconds up to the click (Houston) or 12.47 seconds up to click “Hannover”. With the SERPs without miniaturized Google maps it was only 7.69 s (Houston) or 6.72 s (Hannover). At the same time, the data under complementary conditions once more showed that the length of time on the page and therewith the cognitive load for the national destination (Hannover) is less as opposed to the international destination (Houston). Fig. 2 illustrates the high relevance of the top two links for gaining visual attention. Because the Google advertisements are missing in this listing for lack of fixation on any of them, the eyes of their viewers seem to reveal their ineffectiveness.

If the assumption is correct that the elements in the upper half of the SERPs have a special significance, this should show up in the parameter that indicates the time interval from the beginning of the presentation of the SERP until the first fixation of the defined AOI. The shorter the time interval, the quicker the visual attention of the user is won. For methodical reasons the processing of the data does not start at zero but at 300 milliseconds. This is necessary because the eyes are directed towards the screen before showing the SERP. If



this parameter was determined exactly from the moment of showing, there would be a risk that the data would be subjected to a carry-over effect. The 300 milliseconds consider this condition and allow enough time for orientation. Additionally a pre-test was used to determine a value that limits the interval upwards. A random sample of ten additional subjects recruited for this pre-test did not need more than three seconds until the click. If it is interesting how soon the subjects of the pilot study devoted their interest to the various AOI on the four SERPs, the onset of the measurement relates to the moment 0.3 s after showing the respective SERP. All initial fixations later than 3.3 s after stimulus onset were regarded as critical in respect of the potential processing because, on average, after this point in time a decision already had been made. In the following the average values for the time elapsed until the first fixation of the AOI of the four SERPs is listed.

Figure 3. Seconds until first fixation of AOI of the four SERPs.

The distribution of the first fixation of the AOI of the four SERPs clarifies that pictures strongly attract visual attention. For the statistical procedure the average for TFF data 'Google mini map' and 'Google maps-link' were computed and the average in TFF data for all other links were additionally computed. $M_{map}=1.22$ s, $M_{other\ links}=3.39$ s were compared by t-test und revealed a statistical significant difference ($t_{(18)}=-4.387$, $p<.001$, $d_z=1.006$). The upper design elements, like the miniaturized Google maps, the first four search result links and in part the Google maps links attract a strong spontaneous attention.

5. CONCLUSIONS

In conclusion, some recommendations for actions of providers of internet-based map services could be pronounced. Empirical evidence suggested that those providers should improve their position on search engine results pages. The map service by Hot Maps will be more noticed and chosen by users, the higher up

it is presented on a SERP. On the other hand the data from the questionnaires showed that Hot Maps was not recognized as relevant provider of internet-based map services. So, if this provider wants to become part of the subjects' relevant set, they have to increase their brand awareness on SERPs, which is deeply bound to the users' visual attention.

Because the users' visual attention was massively affected by images placed on SERPs, those production design elements seem to be the right way for service providers to get on consumers' relevant set. As the results revealed, the users got attended but they did also waste a lot of time during their task. These results were in line with the theoretical assumptions by Norman (1981, 2004), Vorderer and Bryant (2006) and with the theory of 'amount of invested mental effort' (Solomon and Leigh, 1984). So, one may say that additional visual information leads to the detriment of efficiency and subsequently also to user's satisfaction, as long as they operated in a task mode. This kind of self promotion was currently Google's unique advertising proposition and the reason why business rivals made this a lawsuit.

Besides to the main effects, the results showed some additional findings. First, and against the common expectance (Mattenklott, 2004), the Google advertisements were not noticed by the participants at all and therefore the implementation of Google ads has to be judged as not effective. This side effect will be worth to get studied in additional experiments. If it can be replicated, the value of internet-ads has to be reconsidered. Maybe this effect was caused by the kind of instruction that was given to the participants. Participants tried to receive information as soon as possible. They were, as Hassenzahl (2003) called it, in a goal mode where people focus on a task. If the trigger hadn't been a goal mode but an action mode (e.g. simply having fun), maybe during the use of social net applications, subjects would have broaden their perceptual field more and spent more attention on additional information (Solomon and Leigh, 1984). The method of instruction is one of the limitations of the presented study.

In this pilot study indications were found that viewing and clicking behavior can be related to mental maps (Downs and Stea, 2005). This circumstance is to be taken into account in additional studies in order to examine it for systematics. Should the finding be verified, the presentation of the service should be adjusted to these expectations of the users.

The limitations of this study, next to the method of instruction, were the small sample size and the shortened validity caused by the laboratory setting, as well as the use of static images of SERPs instead of dynamic SERPs. Finally, the sample's recruitment was not by chance and that limits the results' generalizability. For an extension of this study it will be useful to use a straight between-subjects design with parallel groups and larger sample sizes allowing to verify the effects stated above. Additionally, more parameter in sense of a concept of stress should be used like pupil dilation (Henckens et al., 2009), galvanic skin reaction (Strasser et al, 2009) and heart rate variability (Berntson and Cacioppo, 2004), to extend the current pilot study.

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